National Aeronautics and Space Administration

Going Boldly Beyond: Progress on NASA's Space Launch System

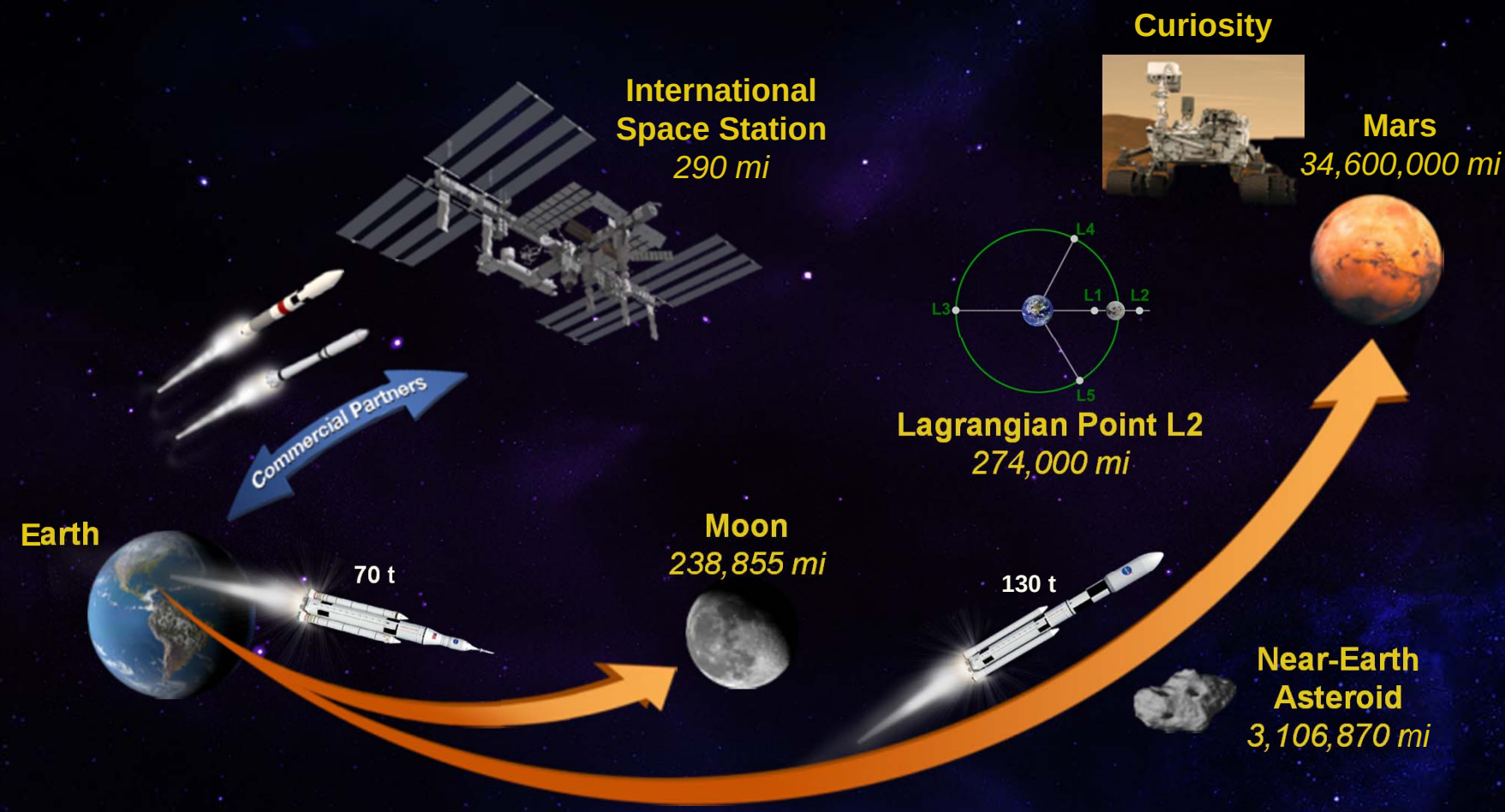
Jody Singer, Deputy Manager
Space Launch System (SLS) Program

NASA Marshall Space Flight Center

February 21, 2013

Space Launch System

The Future of Exploration



The Space Launch System [will] be the backbone of its manned spaceflight program for decades. It [will] be the most powerful rocket in NASA's history…and puts NASA on a more sustainable path to continue our tradition of innovative space exploration.

President Obama's Accomplishments for NASA
May 22, 2012

Advancing the U.S. Legacy of Human Exploration

Building on the U.S. Infrastructure

INITIAL CAPABILITY, 2017–21

70 t
320 ft

Orion Multi-Purpose Crew Vehicle (MPCV)
- ***Lockheed Martin***

Launch Abort System
- ***Orbital Sciences Corp.***

Interim Cryogenic Propulsion Stage
- Early flight certification for Orion
- Flexible for a range of payloads
- ***Boeing***

Core/Upper Stage
- Common design, materials, & manufacturing
- ***Boeing***

Avionics
- Builds on Ares software
- ***Boeing***

5-Segment Solid Rocket Boosters
- Upgrading Shuttle heritage hardware
- ***ATK***

RS-25

Core Stage Engines
- Using Space Shuttle Main Engine inventory assets
- Building on the U.S. state of the art in liquid oxygen/hydrogen
- ***Initial missions: Pratt & Whitney Rocketdyne***
- ***Future missions: Agency is determining acquisition strategy***

Evolutionary Path to Future Capabilities
- **Minimizes unique configurations**
- **Allows incremental development**
- ***Advanced Development contracts awarded in FY13***

EVOLVED CAPABILITY, Post-2021

130 t
384 ft

Fairings (27.5' or 33')
- Right-sized for the payload
- Received industry input in FY13

J-2X Upper Stage Engine
- Builds on Apollo Saturn J-2 heritage
- ***Pratt & Whitney Rocketdyne***

Advanced Boosters
- Competitive opportunities for affordable upgrades
- ***Risk-reduction contracts awarded in FY13***

Working with Industry Partners to Develop America's Heavy-Lift Rocket

SLS Driving Objectives

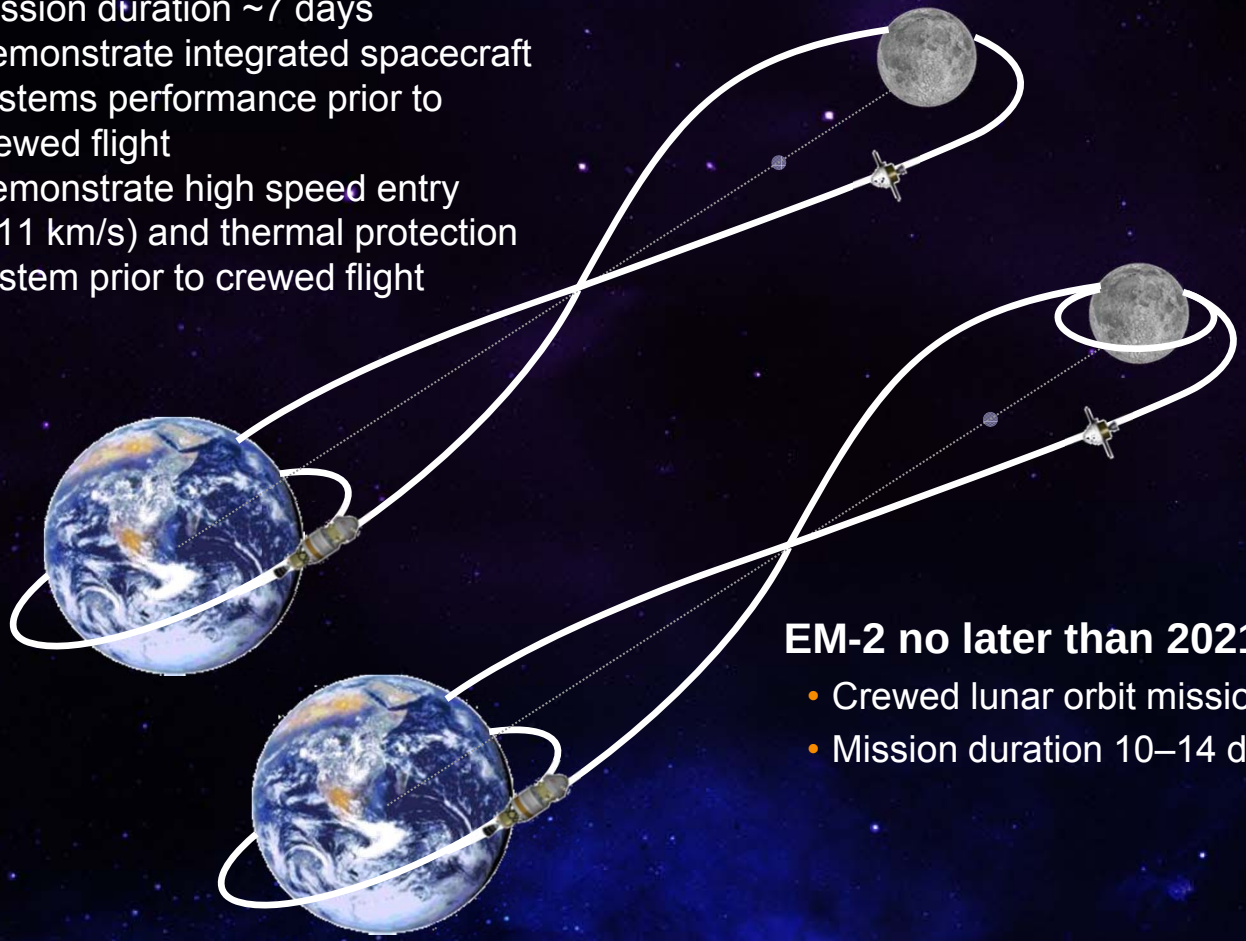
- **Safe**
  - Human-rated to provide safe and reliable systems for human missions
  - Protecting the public, NASA workforce, high-value equipment and property, and the environment from potential harm
- **Affordable**
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Constrained budget environment
  - Competitive opportunities for affordability on-ramps
- **Sustainable**
  - Initial capability: 70 metric tons (t), 2017–2021
    - Serves as primary transportation for Orion and exploration missions
    - Provides back-up capability for crew/cargo to ISS
  - Evolved capability: 105 t and 130 t, post-2021
    - Offers large volume for science missions and payloads
    - Modular and flexible, right-sized for mission requirements

Flexible Architecture Configured for the Mission

Initial Exploration Missions (EM)

EM-1 in 2017

- Un-crewed circumlunar flight – free return trajectory
- Mission duration ~7 days
- Demonstrate integrated spacecraft systems performance prior to crewed flight
- Demonstrate high speed entry (~11 km/s) and thermal protection system prior to crewed flight



EM-2 no later than 2021

- Crewed lunar orbit mission
- Mission duration 10–14 days

The Road to First Flight in 2017

NASA Life Cycle Phases	Approval for Formulation ▼	FORMULATION	▽ Approval for Implementation	IMPLEMENTATION			
Program Life Cycle Phases	Pre-Phase A: Concept Studies	Phase A: Concept & Technology Development	Phase B: Preliminary Design & Technology Completion	Phase C: Final Design & Fabrication	Phase D: System Assembly, Int. & Test, Launch & Checkout	Phase E: Operations & Sustainment	Phase F: Closeout
Program Life Cycle Gates and Major Events		KDP A ✔	KDP B ✔	KDP C ▽ EFT-1 Launch	KDP D ▽ EM-1 Launch	KDP E ▽ EM-2 Launch	KDP F ▽
Human Space Flight Project Reviews	MCR ▼ ✔ 2011	SRR/SDR ▼ ✔ 2012	PDR ▽ 2013	CDR ▽ 2015	SR ▽ 2016	FRR ▽ 2017	▽ 2021

FOCUSED TOWARD

We don't do a good job… pointing out the monumental effort that has gone into this Program…. I don't think anyone would have thought in September [2011] that this Program might be this far so fast.

Leroy Cain, Chair
Independent Standing Review Board
(NASA Space Shuttle Program Flight Director)
NASA Directorate Program Management Council
June 29, 2012

SLS: A Year of Accomplishments

Systems Engineering and Integration SLS model undergoes wind tunnel testing at Langley Research Center Nov 2012

J-2X power pack assembly hot fire test at Stennis Space Center Nov 2012

Multi-Purpose Crew Vehicle Stage Adapter (MSA) Pathfinder Hardware at Marshall Space Flight Center June 2012

Kennedy Space Center Complex 39B ready for a 2017 SLS launch (artist's concept)

RS-25 Engines at Stennis Space Center Oct 2012, shown with future RS-25 Test Stand A1

F-1 engine gas generator hot fire test at Marshall Space Flight Center, Jan 2013 – technology development for an optional Advanced Booster concept

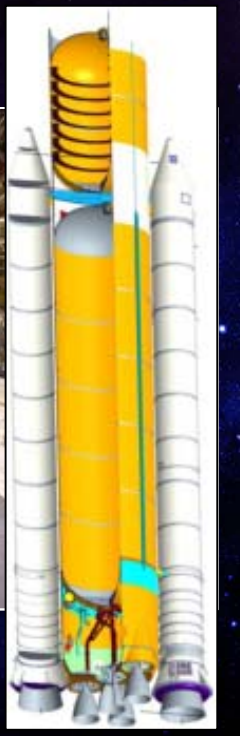
Qualification Motor 1 casting at ATK Oct 2012

System Requirements Review/System Definition Review Completed

Marshall's Michoud Assembly Facility (MAF)

- **SLS Stages Element**
  - Manufacturing Core Stage and Upper Stage
  - Manufacturing Instrument Ring
  - Integrating Engines with Core and Upper Stages
- **Building key parts of the Orion multipurpose crew vehicle (MPCV)**
  - Composite components of the Crew Module, Service Module, and Launch Abort System
  - Crew Module and Service Module primary structure
- **Suppliers and subcontractors at MAF can collocate with their customers**
  - Utilize the same world-class infrastructure, equipment, and services
  - Significantly reduce logistics cost and delivery time by sharing common space

Orion/MPCV



Core Stage

SLS Program Organization at MSFC

1/09/13

Hard line programmatic
Matrix relationship

Program Manager Todd May | Deputy Manager Jody Singer | Associate Program Manager Vacant | Assistant Program Manager Sharon Cobb

Chief Engineer (CE) Garry Lyles

Deputy CE John Honeycutt

Strategic Development Manager Steve Creech (XP01)

Chief Safety Officer (CSO) Rick Burt

Deputy CSO Dan Mullane

Program Integration Manager Mark Richards (XP02)

Procurement Manager Earl Pendley

Program Planning & Control Manager Keith Hefner

Deputy Manager Daryl Woods

Boosters Manager Alex Priskos

Deputy Manager Bruce Tiller

Engines Manager Mike Kynard

Deputy Manager Sheryl Kittredge

Stages Manager Tony Lavoie

Deputy Manager Julie Bassler

Ground Operations Liaison Manager Brian Matisak

Assistant Manager Andy Warren

Advanced Development Office Manager Chris Crumbly

Assistant Manager Fred Bickley

Spacecraft & Payload Integration Manager David Beaman

Vacant

Assistant Manager

SLS Contractor Support

2011 Data

- Engaging the U.S. Aerospace Industry
- Strengthening Sectors such as Manufacturing
- Advancing Technology and Innovation

270 Subcontracts in 34 States

SLS Small Business Goals

- **NASA's Small Business Policy (NASA Policy Directive 5000.2C) has been assessed for SLS requirements:**
  - Stages
  - Engines
  - Interim Cryo-Propulsion Stage
  - Advanced Booster NASA Research Announcement (NRA)
  - Advanced Development NRA
- **Subcontracting plan goals for existing contracts are being updated via negotiations.**
- **SLS provides topics to the Small Business Innovation Research (SBIR) Program:**
  - Link to the NASA SBIR website is listed on all solicitations
    - http://sbir.gsfc.nasa.gov/SBIR/SBIR.html
- **For all incentive approaches, small business utilization performance is evaluated:**
  - Mentor/Protégé Program is included

Targeting Robust Small Business Partnerships Through Various Channels

SLS Acquisition Summary

- **SLS contract activity continues to evolve per the initial acquisition strategy**
- **Acquisition strategy meets key SLS requirements of *safety, affordability, and evolvable performance***
- **SLS continues to work closely with NASA's Office of Small Business Programs to maximize opportunities for all parts of the Agency's socio-economic programs**
- **Contact information: Earl Pendley**
  - Phone: 256–544–2949
  - email: george.e.pendley@nasa.gov

Launching 2017

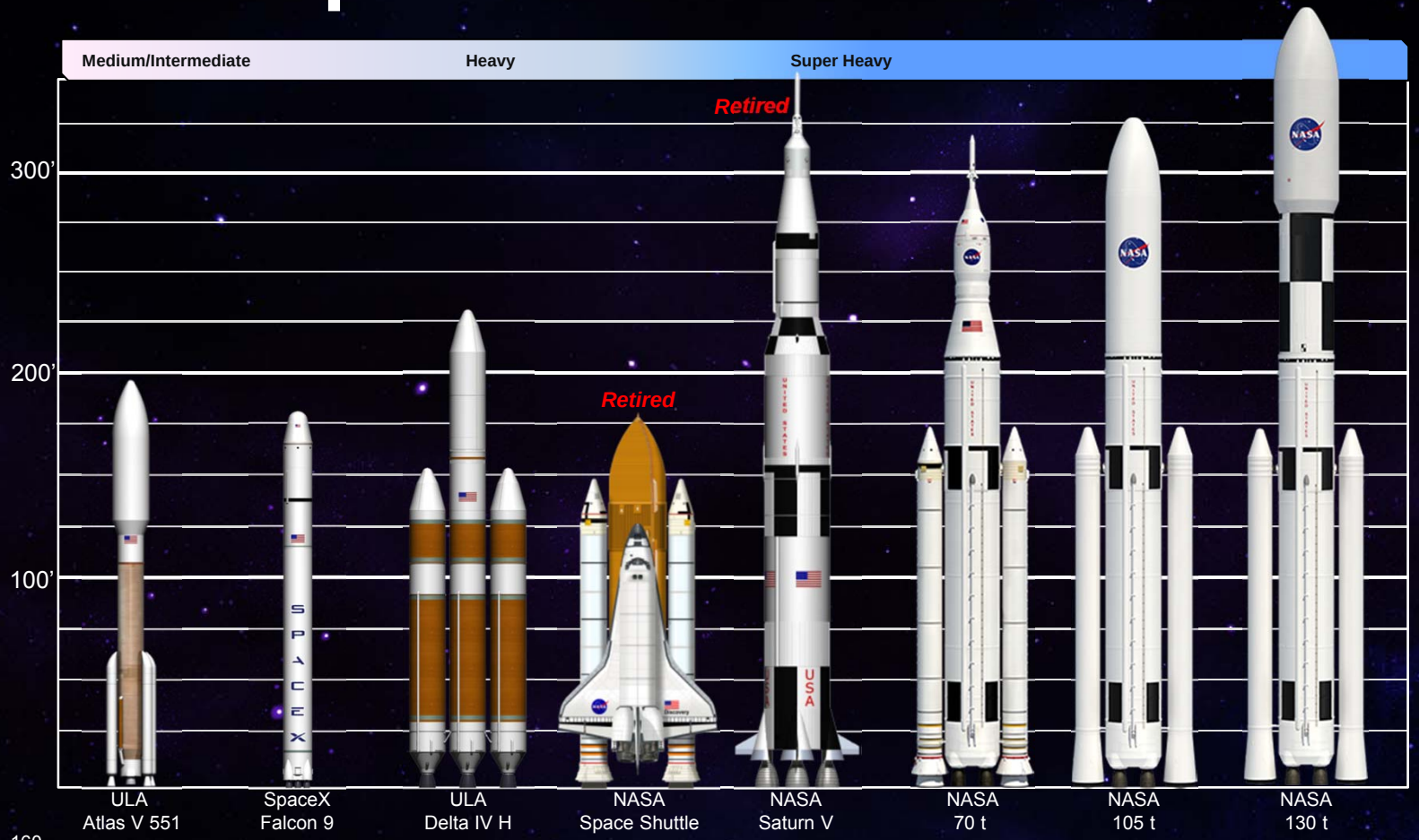
National Aeronautics and Space Administration

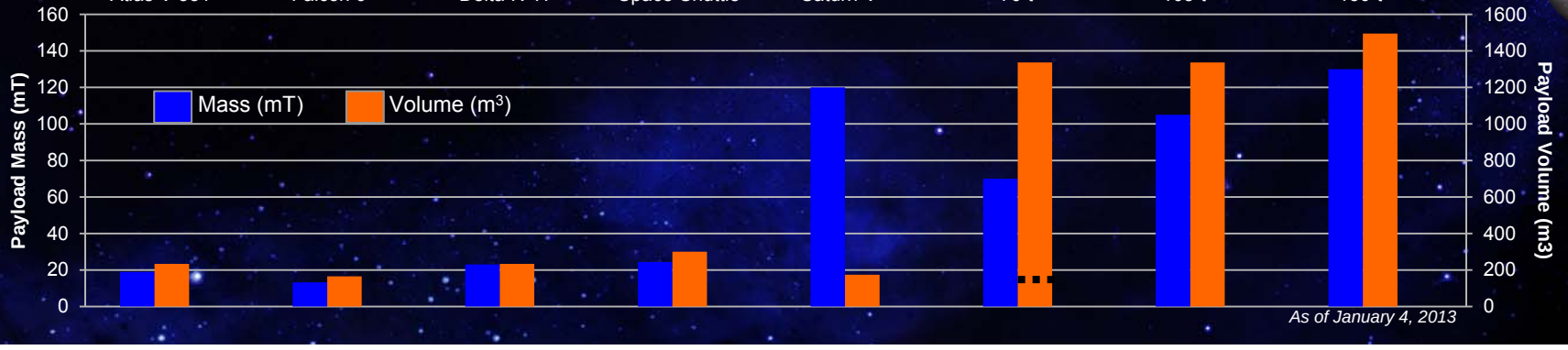
NASA's Space Launch System *Advanced Development Overview*

Chris Crumbly
SLS Advanced Development Manager
February 21, 2013

Space Launch System

Most Capable U.S. Launch Vehicle





As of January 4, 2013

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Three-Phase Booster Development

Full and Open Competition

Advanced Booster Design, Development, Test, and Evaluation (DDT&E)

- Scope: Follow-on procurement for DDT&E of a new booster
- Date: RFP target is FY15
- Capability: Evolved at 130 t
- Contract: Full and Open Competition (Liquids or Solids)

Full and Open Competition

Advanced Booster Engineering Demonstration and/or Risk Reduction NRA

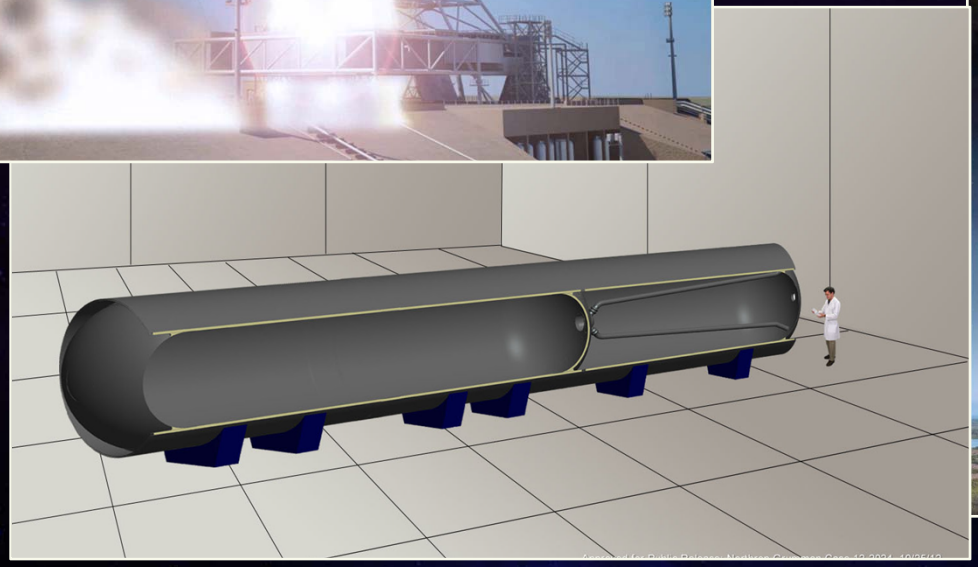
- Scope: Award contracts that reduce risks leading to an affordable Advanced Booster that meets the evolved capabilities of SLS and enable competition by mitigating targeted Advanced Booster risks to enhance SLS affordability
- Date: ***Contracts awarded Oct 1, 2012***
- Capability: Leading to 130 t
- Contract: NRA Demonstrating Specific Technologies and Affordability Risk Reduction for Advanced Boosters
  - Liquid Rocket Boosters or Solid Rocket Boosters

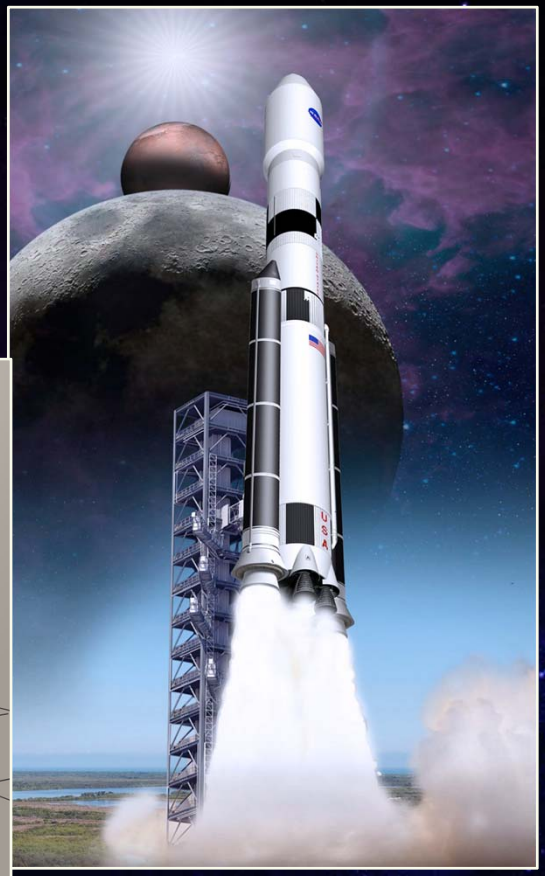
Booster Fly-out for Early Flights through 2021

- Scope: Build two 5-segment SRB Flight Sets
- Date: In progress
- Capability: Initial 70–100 t
- Contract: Mod to Ares contract with ATK

Moving Forward from Initial to Evolved Capability

Advanced Booster Research





- The Advanced Booster Engineers Demonstration and Risk Reduction (ABEDRR) effort will reduce risks and enable competition, leading to an affordable Advanced Booster that meets the evolved capabilities of SLS and enable competition.

F-1B Risk Reduction

Affordable Upper Stage Engine

- Partnership between NASA and U.S. Air Force to support the development of an affordable upper-stage engine that could reduce launch costs for Evolved Expendable Launch Vehicles and could potentially provide an alternative for the SLS cryogenic propulsion stage.

A Nationwide Endeavor

NASA Advanced Development

SLS is using selective laser melting to manufacture engine components

- **In addition to contracts with industry and academia, NASA is conducting research within the agency into new technologies to increase SLS affordability, reliability and performance.**

NASA's Space Launch System

- **NASA's Space Launch System is implementing an evolvable configuration approach to system development in a resource-constrained era**
  - Legacy systems enable non-traditional development funding and contribute to sustainability and affordability
  - Limited simultaneous developments reduce cost and schedule risk
  - Phased approach to advanced booster development enables innovation and competition, incrementally demonstrating affordability and performance enhancements
  - Advanced boosters will provide performance for the most capable heavy lift launcher in history, enabling unprecedented space exploration benefiting all of humanity

Preliminary Design Review 2013

Launching in 2017

For More Info:
www.nasa.gov/sls

For More Information

www.nasa.gov/sls

www.twitter.com/nasa_sls

www.facebook.com/nasasls